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July 16, 2018

Mr. Robert Spiegel
Executive Director
Edison Wetlands Association
206 Tyler Road
Edison, New Jersey 08820

Re: Area Residential Vapor Intrusion Sampling and Testing
Former Amphenol Facility #IND 044587 848
980 Hurricane Road
Franklin, Indiana, 46131
MUNDELL Project No. M18027

Dear Mr. Spiegel:

In response to the Edison Wetlands Association Inc. Request for Proposal (RFP) to Mundell & Associates, Inc. (MUNDELL), a professional environmental engineering company based in Indianapolis, we have prepared and executed Proposal No. P18041-R1. MUNDELL is pleased to provide to the Edison Wetlands Association (EWA), the results of our recent residential vapor intrusion sampling and testing program. The following paragraphs summarize the sampling and testing methodologies and the analytical testing results.

INTRODUCTION

At 08:00 on June 20, 2018, MUNDELL mobilized to Franklin, Indiana to perform vapor testing services for the Edison Wetlands Association. The vapor testing involved placing either air sampling Summa-type canisters and/or passive sampling units (Radiello-130) at each residence. A single radon test was also placed at the lowest location in each of the homes (basement, crawl space or first floor, depending on residence construction). The chemical constituents of interest include the following chlorinated compounds: tetrachloroethylene (PCE), trichloroethylene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), cis-1,2-dichloroethylene (cis-1,2-DCE), trans-1,2-dichloroethylene (trans-1,2-DCE) and vinyl chloride (VC).

Fourteen (14) residences located in Franklin, Indiana were sampled on June 20, 2018. In the interest of preserving privacy and confidentiality of the residences in the public forum, addresses have been labelled as "Home #1" through "Home #14" in no particular order. All homes sampled were within an approximately 0.3 to 5.6 mile radius of the former Amphenol Facility (Amphenol site) on 980 Hurricane Road, Franklin, Indiana 46131. Maps showing general sampling locations are appended in Figure 1.

MUNDELL & ASSOCIATES, INC.



The following sections summarize background information on the Amphenol site, analytical data results from this sampling event, and provide recommendations for future actions.

SITE BACKGROUND

The approximately 15 acre former Amphenol Corporation site (Amphenol) is located on 980 Hurricane Road, Franklin, IN, and was utilized for the manufacturing of electrical parts in the 1960s through the 1980s. Wastes generated and stored at the site during this time were reported to include metal hydroxide sludge, volatile organic compound (VOC) solvents and thinners, and cyanide solutions. According to Bendix Connector Corporation, the predecessor of Amphenol, these wastes leaked through the facility's floor and were discharged through a cracked sanitary sewer line. Unregulated discharges of hazardous chemicals significantly contaminated surrounding site soil, groundwater and surface water. A network of on-site monitoring wells was installed in the 1980s, and a groundwater recovery system reportedly began operating on the property in 1995.

Significant data gaps were uncovered during review of the Amphenol site history, including but not limited to:

- A 1995 memo by U.S. EPA hydrogeologist Steven D. Acree noted, "In general, it appears that site conditions necessary to evaluate contaminant transport and fate processes/rates are not well-defined, particularly in Operable Unit (OU) 3. Relatively little information regarding site hydrogeology and contaminant nature/distribution appears to be available for this part of the site." The extent and migration of the groundwater plume still has not been fully characterized after this time, particularly in the off-site and residential areas.
- In 1996, a "Draft Indoor Air Evaluation" was performed using modeling techniques to assess potential impacts to residents on the adjacent Forsythe Street, but its conclusions were not validated with field data. The potential for vapor intrusion and risk to residences near the Amphenol site has not been adequately addressed.
- October 2016 groundwater data shows the highest concentrations of total VOCs (954.5 ppb) were recently detected in a monitoring well (MW-12R) less than 25 feet away from the residential area on Hamilton Avenue. A source area for the groundwater contamination may still be present, and the groundwater plume could impact private drinking water wells or indoor air through vapor intrusion.

The Amphenol site is currently monitored under the Resource Conservation and Recovery Act (RCRA) and is reported by the U.S. Environmental Protection Agency (U.S. EPA) to be in the Operation and Maintenance (O&M) phase. Given the data gaps referenced above, more investigatory work must be completed to ensure that human health and environmental exposures are under control.



Three wells in the Webb Wellfield (Webb), located approximately 3500 feet northeast of the Amphenol site, were shut down between 2007 to 2012 due to cis-1,2-DCE, trans-1,2-DCE, and TCE detections found above Maximum Contaminant Levels (MCLs) in or near the wells. Webb was part of Indiana American Water Company's distribution system, which provided drinking water to over 78,000 people, according to the Indiana Department of Environmental Management (IDEM). Questions as to the origin of the contamination in the wellfield, the extent and migration of the groundwater plume, and potential risks to nearby residences and private wells remain unanswered, and further underscores the significance of this investigation.

RADON TESTING RESULTS

A single radon test was placed at the lowest location in each of the homes (basement, crawl space or first floor, depending on residence construction). The tests were collected after a 48-hour residency time and returned to the Radon Testing Corporation of America for analysis. Results are summarized in **Table 1**.

The United States Environmental Protection Agency (U.S. EPA) recommends that action be taken to reduce radon levels if they exceed 4 picocuries per liter (pCi/L) in active living spaces of the home. In **Table 1**, six (6) of the fourteen (14) houses tested had a radon reading that exceeded the 4 pCi/L level. MUNDELL recommends that these six residences have a repeat radon test performed in the original test space (crawl space or basement) for confirmation purposes, as well as a radon test performed on the first floor of each house to determine whether radon from the crawl spaces or basements is migrating upward into the residences.

In **Attachment 1** is the U.S. E.P.A. Guide to Radon. This is an information resource that can provide guidance on further testing for radon and potential mitigation approaches. MUNDELL recommends that this guide be provided to the home owners who participated in this testing event.

INDOOR AIR TESTING RESULTS

FROG Gas Chromatograph

The FROG 4000 mobile gas chromatograph unit was used to test an air sample at each house. The unit was calibrated by the manufacturer (Defiant Technologies) for the following compounds: PCE, TCE, cis-1,2-DCE and trans-1,2-DCE. The unit draws in a sample of air for approximately 20 seconds and then analyzes the sample to produce a chromatograph. Most of the samples taken did not have any apparent detection of the aforementioned compounds. The FROG sample collected in the basement sump of Home #8 appeared to initially indicate a detection of TCE. However, the laboratory-analyzed air canister sample collected in the basement near the sump in question did not have any detection of chlorinated compounds. It is possible that apparent TCE detection in the FROG sample collected in the basement sump of Home #8 was caused by matrix interference from other compounds.



Indoor Air Sampling

Air samples were collected for analysis using a combination of twenty-three (23) Summa-type canisters and six (6) passive samplers (Radiello-130). The air canisters were 6-liters in volume and equipped with a regulator allowing for 24 hours of sampling time. The Radiello-130 passive samplers consisted of an absorbent material that was exposed for a period of 24 hours.

Laboratory analyses for the air canisters were performed via U.S. EPA Method TO-15 for a list of six constituents including PCE, TCE, 1,1,1-TCA, cis-1,2-DCE, trans-1,2-DCE and vinyl chloride. Laboratory analyses for the passive samplers were performed via U.S. EPA Modified Method TO-17 for the following compounds: PCE, TCE, 1,1,1-TCA, cis-1,2-DCE and trans-1,2-DCE. Passive sampler results for cis-1,2-DCE and trans-1,2-DCE are estimated, while vinyl chloride results are not possible with the passive sampler units.

The analytical results are presented in **Table 1**. The ambient air canister sample contained detections of PCE, TCE, 1,1,1-TCA and cis-1,2-DCE. The concentrations for PCE and TCE in the ambient air sample exceeded their respective 2018 IDEM Residential Indoor Air screening levels. TCE is a known human carcinogen by all routes of exposure and PCE is a likely human carcinogen.

Samples collected from ten (10) of the houses tested had analytical results below the method reporting limit and are considered non-detect for the compounds tested.

The air canister sample collected from the dining room and the passive sample collected from the upstairs 'bonus' room of Home #4 contained **PCE concentrations of 6.51 $\mu\text{g}/\text{m}^3$ and 1.4 $\mu\text{g}/\text{m}^3$, respectively**, which are below the 2018 IDEM Residential Indoor Air screening level. The residents of this household have clothing dry-cleaned and these low concentrations of PCE may be related to the presence of dry-cleaned clothes in the residence.

The air canister sample collected from the crawl space of Home #5 was non-detect for the tested compounds; however the passive sample collected from the living room space had a detection of **PCE at 1.4 $\mu\text{g}/\text{m}^3$** , below the 2018 IDEM Residential Indoor Air screening level. The residents of this household have clothing dry-cleaned and these low concentrations of PCE may be related to the presence of dry-cleaned clothes in the residence.

The air canister samples collected from the crawl space and dining room of Home #12 both contained **PCE at a concentration of 18.38 $\mu\text{g}/\text{m}^3$ and 18.86 $\mu\text{g}/\text{m}^3$, respectively**. While these concentrations are below the 2018 IDEM Residential Indoor Air screening level, it suggests that some form of vapor intrusion is potentially occurring at this residence.

The air canister sample collected from the living room of Home #6 contained **PCE at 27.47 $\mu\text{g}/\text{m}^3$** (below the IDEM Residential Indoor Air screening level), **TCE at 7.79 $\mu\text{g}/\text{m}^3$** (exceeding the 2018 IDEM Residential Indoor Air screening level) and **1,1,1-TCA at 5.02 $\mu\text{g}/\text{m}^3$** (below the IDEM Residential Indoor Air screening level). The air canister sample collected from the crawl space of Home #6 was non-detect for all tested compounds. This suggests that there



is either an indoor source for the living room sample or that contaminated ambient air is entering the living room space.

The air canister sample collected in the first-floor kitchen space of Home #13 contained detections of **PCE at 126.63 $\mu\text{g}/\text{m}^3$** (exceeding the IDEM Residential Indoor Air screening level), **TCE at 39.61 $\mu\text{g}/\text{m}^3$** (exceeding the 2018 IDEM Residential Indoor Air screening level) and **1,1,1-TCA at 7.48 $\mu\text{g}/\text{m}^3$** (below the IDEM Residential Indoor Air screening level). The air canister sample collected in the finished basement of Home #13 was non-detect for all tested compounds. This suggests that there is either an indoor source for the upstairs kitchen sample or that contaminated ambient air is entering the kitchen space.

RECOMMENDATIONS

Radon Sampling

MUNDELL recommends that all homes sampled on June 20, 2018 have repeat radon testing performed, especially the following six (6) residences that exceeded U.S. EPA's action level of 4.0 pCi/L:

- 1) Home #1 – 6.7 pCi/L
- 2) Home #2 – 6.7 pCi/L
- 3) Home #6 – 7.6 pCi/L
- 4) Home #11 – 5.9 pCi/L
- 5) Home #12 – 7.2 pCi/L
- 6) Home #13 – 4.1 pCi/L

These houses should have radon tests repeated in their respective basement or crawl space to confirm results, along with a radon test conducted in the main floor living space to determine whether radon from the crawl spaces or basements is migrating upward into the residences.

Indoor Air Sampling

MUNDELL recommends that all homes sampled on June 20, 2018 have repeat indoor air testing performed, with a priority on the following three (3) residences:

- 1) Home #6 – Living room: PCE 27.47 $\mu\text{g}/\text{m}^3$, TCE 7.79 $\mu\text{g}/\text{m}^3$, 1,1,1-TCA 5.02 $\mu\text{g}/\text{m}^3$
- 2) Home #12 – Crawl space: PCE 18.38 $\mu\text{g}/\text{m}^3$
Dining room: PCE 18.86 $\mu\text{g}/\text{m}^3$
- 3) Home #13 – Kitchen: PCE 126.63 $\mu\text{g}/\text{m}^3$, TCE 39.61 $\mu\text{g}/\text{m}^3$, 1,1,1-TCA 7.48 $\mu\text{g}/\text{m}^3$

Another round of indoor air testing is required to confirm the results for these residences. This follow-up testing should duplicate the samples that were collected on June 20th, 2018 (*i.e.*, basements/crawl spaces should be retested along with the first floor indoor air). MUNDELL recommends collecting a sub-slab vapor sample from the Home #13 residence. If the owners do not wish to have drilling performed in their house, a soil gas sample could be collected adjacent



to the structure instead. For the Home #6 and Home #12 locations with crawl spaces, soil gas samples can be collected adjacent to each structure.

In conjunction with repeat indoor air testing, MUNDELL recommends pairing an ambient air can with each individual house to better determine whether ambient air is a potential source of contaminants. Expedited future sampling events should also be expanded to include more residences closest to the site and in the vicinity of residences with exceedances as identified by this sampling program.

Ambient Air Testing around Former Amphenol Facility

The ambient air canister placed in the yard of Home #2 had detections of four (4) chlorinated compounds, two of which (PCE and TCE) were well above the IDEM 2018 residential indoor air screening levels of $42 \mu\text{g}/\text{m}^3$ and $2.1 \mu\text{g}/\text{m}^3$, respectively:

Home #2 – Back yard: PCE $171.73 \mu\text{g}/\text{m}^3$, TCE $52.61 \mu\text{g}/\text{m}^3$, 1,1,1-TCA $13.1 \mu\text{g}/\text{m}^3$, cis-1,2-DCE $3.21 \mu\text{g}/\text{m}^3$

This location is 3,276 feet southwest of the Former Amphenol facility. This facility currently has an operating groundwater pump-and-treat remediation system that does not appear to have a carbon treatment filter on the vent stack and, therefore, is likely to be venting chlorinated compounds into the air.

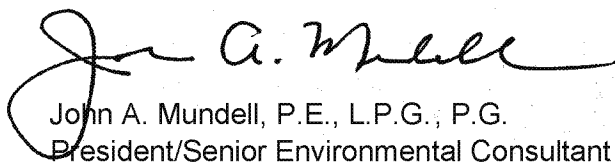
The facility structure had vapor intrusion mitigation systems installed that, if still operating, could also be contributing chlorinated compounds into the air. It is possible that the ambient air sample could have detected chlorinated compounds being released by the mitigation and remediation systems at the Former Amphenol facility.

MUNDELL recommends more extensive sampling of the ambient air downwind of and around the Former Amphenol facility, including the discharge vent on the pump-and-treat system and vapor intrusion mitigation system vents, to confirm if these are sources of the elevated ambient air impacts.

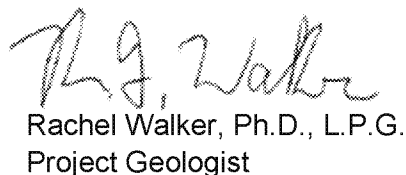
We appreciate the opportunity to provide services to you on this project. If you should have any questions regarding this letter and the analytical results, please feel free to contact us at (317) 630-9060 or via email at jmundell@MundellAssociates.com.

Sincerely,

MUNDELL & ASSOCIATES, INC.



John A. Mundell, P.E., L.P.G., P.G.
President/Senior Environmental Consultant



Rachel Walker, Ph.D., L.P.G.
Project Geologist

/rw



Attachments:

Tables**Figures****Attachment No. 1:** U.S. EPA Guide to Radon**Attachment No. 2:** ATSDR ToxFAQs

TABLES

Table 1
Analytical Results
Franklin VI Project
MUNDELL Project No. M18027

Sample Number	Sample Collection Date	Sampling Location	Tetrachloroethylene (PCE)	Trichloroethylene (TCE)	1,1,1-Trichloroethane	cis-1,2-Dichloroethylene	trans-1,2-Dichloroethylene	Vinyl Chloride	Radon
			µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	pCi/L
1	6/20/2018	Crawl Space	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	6.7
		Living Room	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	n/t
2	6/20/2018	Crawl Space	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	6.7
		Dining Room	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	n/t
3	6/20/2018	Living Room	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	1.4
		Upstairs Room**	<1.2	<1.0	<1.1	<1.1	<2.3	n/t	n/t
4	6/20/2018	Dining Room	6.51	<1.34	<1.36	<0.99	<0.99	<0.64	1.9
		Upstairs Room**	1.40	<1.0	<1.1	<1.1	<2.3	n/t	n/t
5	6/20/2018	Crawl Space	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	0.5
		Living Room**	1.40	<1.0	<1.1	<1.1	<2.3	n/t	n/t
6	6/20/2018	Crawl Space	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	7.6
		Living Room	27.47	7.79	5.02	<0.99	<0.99	<0.64	n/t
7	6/20/2018	Crawl Space	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	2.2
		Living Room	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	n/t
8	6/20/2018	Basement	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	0.8
		Living Room**	<1.2	<1.0	<1.1	<1.1	<2.3	n/t	n/t
9	6/20/2018	Basement	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	3.4
		Living Room	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	n/t
10	6/20/2018	Living Room	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	0.2
		Upstairs Room**	<1.2	<1.0	<1.1	<1.1	<2.3	n/t	n/t
11	6/20/2018	Basement	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	5.9
		Living Room**	<1.2	<1.0	<1.1	<1.1	<2.3	n/t	n/t
12	6/20/2018	Crawl Space	18.38	<1.34	<1.36	<0.99	<0.99	<0.64	7.2
		Dining Room	18.86	<1.34	<1.36	<0.99	<0.99	<0.64	n/t
13	6/20/2018	Basement	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	4.1
		Kitchen	126.63	39.61	7.48	<0.99	<0.99	<0.64	n/t
14	6/20/2018	Crawl Space	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	3.7
		Living Room	<1.7	<1.34	<1.36	<0.99	<0.99	<0.64	n/t
Ambient	6/20/2018	Ambient Outdoor Air	171.73	52.61	13.1	3.21	<0.99	<0.64	n/t
2018 IDEM RCG Residential Indoor Air Screening Level			42	2.1	5,200	--	--	1.7	4.0^
2018 IDEM RCG Commercial Indoor Air Screening Level			180	8.8	22,000	--	--	28	--

Notes:

1) < indicates sample concentration below method reporting limit

2) n/t = not tested

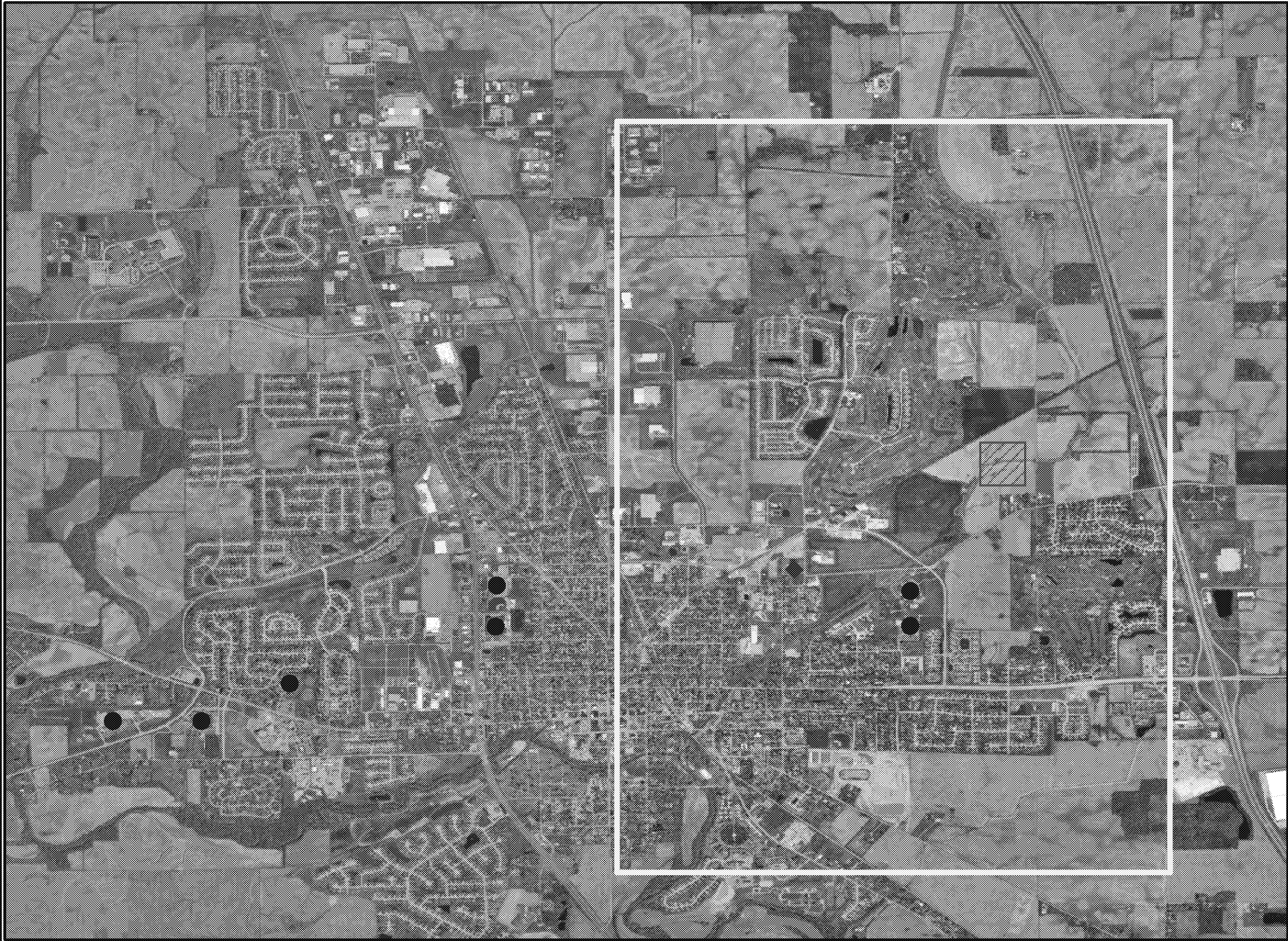
3) Samples collected using Summa-type Canisters and analyzed via U.S. EPA Method TO-15. Samples marked with ** were collected using RAD-130 passive samplers and analyzed using modified EPA Method TO-17.

4) ^ = radon level recommended for action by the U.S. EPA

5) Concentrations in yellow are reported above residential indoor air screening levels

6) Concentrations in orange are reported above commercial indoor air screening levels

FIGURES



Franklin, Indiana

Scale approximately 1" = 0.4 miles

LEGEND

- ◆ Former Amphenol Facility Location
- School Location
- Sample Collection Area
- ▨ Former Webb Wellfield



NOTES:
Map is provided for site reference only.
No claim is made as to the accuracy or
completeness of this information.

Site Map	FIGURE
Franklin VI Project Franklin, Johnson County, Indiana MUNDELL PROJECT NO. M18027	1



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ATTACHMENT 1

U.S. EPA GUIDE TO RADON



A Citizen's Guide to Radon

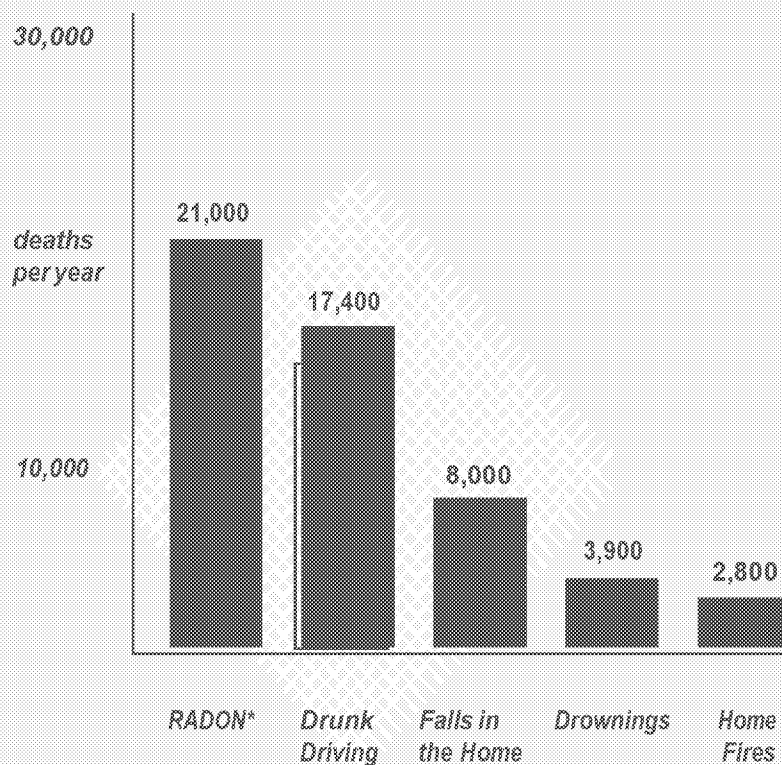
The Guide to Protecting Yourself and Your Family from Radon



EPA Recommends:

- ▼ ***Test your home for radon—it's easy and inexpensive.***
- ▼ ***Fix your home if your radon level is 4 picocuries per liter (pCi/L) or higher.***
- ▼ ***Radon levels less than 4 pCi/L still pose a risk, and in many cases may be reduced.***

Radon is estimated to cause thousands of lung cancer deaths in the U.S. each year.



*Radon is estimated to cause about 21,000 lung cancer deaths per year, according to EPA's 2003 Assessment of Risks from Radon in Homes (EPA 402-R-03-003). The numbers of deaths from other causes are taken from the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Report and 2002 National Safety Council Reports.

OVERVIEW

Radon is a cancer-causing, radioactive gas.

You can't see radon. And you can't smell it or taste it. But it may be a problem in your home.

Radon is estimated to cause many thousands of deaths each year. That's because when you breathe air containing radon, you can get lung cancer. In fact, the Surgeon General has warned that radon is the second leading cause of lung cancer in the United States today. Only smoking causes more lung cancer deaths. **If you smoke and your home has high radon levels, your risk of lung cancer is especially high.**

Radon can be found all over the U.S.

Radon comes from the natural (radioactive) breakdown of uranium in soil, rock and water and gets into the air you breathe. Radon can be found all over the U.S. It can get into any type of building—homes, offices, and schools—and result in a high indoor radon level. But you and your family are most likely to get your greatest exposure at home, where you spend most of your time.

You should test for radon.

Testing is the only way to know if you and your family are at risk from radon. EPA and the Surgeon General recommend testing all homes below the third floor for radon. EPA also recommends testing in schools.

Testing is inexpensive and easy—it should only take a few minutes of your time. Millions of Americans have already tested their homes for radon (see page 5).

You can fix a radon problem.

Radon reduction systems work and they are not too costly. Some radon reduction systems can reduce radon levels in your home by up to 99%. Even very high levels can be reduced to acceptable levels.

New homes can be built with radon-resistant features.

Radon-resistant construction techniques can be effective in preventing radon entry. When installed properly and completely, these simple and inexpensive techniques can help reduce indoor radon levels in homes. In addition, installing them at the time of construction makes it easier and less expensive to reduce radon levels further if these passive techniques don't reduce radon levels to below 4 pCi/L.

Every new home should be tested after occupancy, even if it was built radon-resistant. If radon levels are still in excess of 4 pCi/L, the passive system should be activated by having a qualified mitigator install a vent fan. For more explanation of radon resistant construction techniques, refer to EPA publication, *Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes* (see page 15).

HOW DOES RADON GET INTO YOUR HOME?

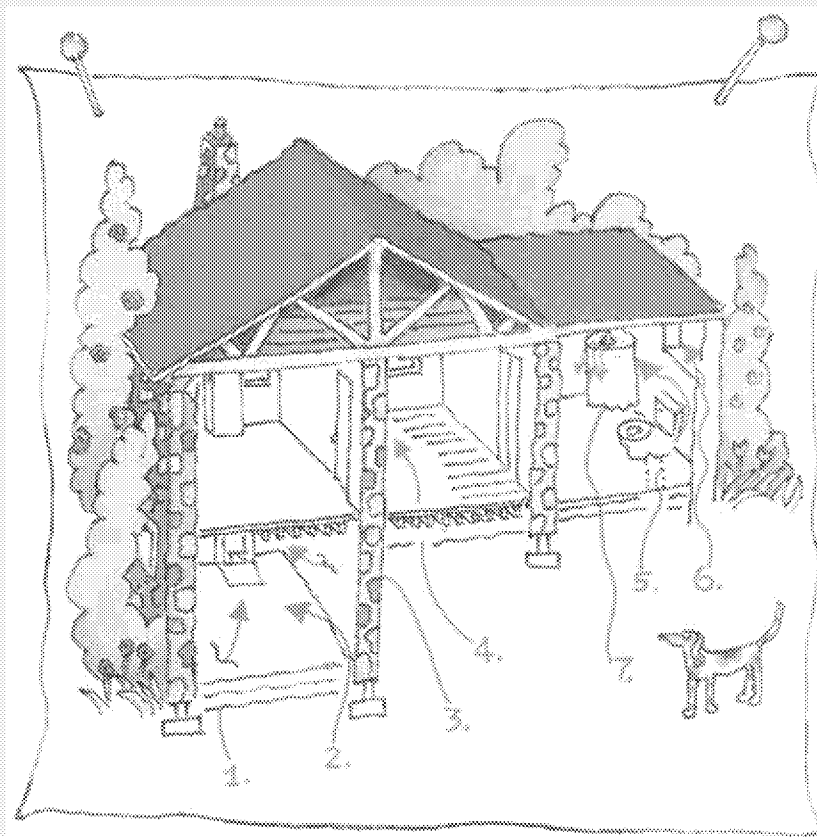
Any home may have a radon problem.

Radon is a radioactive gas. It comes from the natural decay of uranium that is found in nearly all soils. It typically moves up through the ground to the air above and into your home through cracks and other holes in the foundation. Your home traps radon inside, where it can build up. Any home may have a radon problem. This means new and old homes, well-sealed and drafty homes, and homes with or without basements.

Radon from soil gas is the main cause of radon problems. Sometimes radon enters the home through well water (see page 8). In a small number of homes, the building materials can give off radon, too. However, building

RADON GETS IN THROUGH:

- 1. Cracks in solid floors.***
- 2. Construction joints.***
- 3. Cracks in walls.***
- 4. Gaps in suspended floors.***
- 5. Gaps around service pipes.***
- 6. Cavities inside walls.***
- 7. The water supply.***



materials rarely cause radon problems by themselves.

Nearly 1 out of every 15 homes in the U.S. is estimated to have elevated radon levels. Elevated levels of radon gas have been found in homes in your state. Contact your state radon office (<https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>) for general information about radon in your area. While radon problems may be more common in some areas, any home may have a problem. The only way to know about your home is to test.

Radon can also be a problem in schools and workplaces. Ask your state radon office (www.epa.gov/radon/wherelive.html) about radon problems in schools, daycare and childcare facilities, and workplaces in your area (also visit <https://www.epa.gov/radon>).

HOW TO TEST YOUR HOME

You can't see radon, but it's not hard to find out if you have a radon problem in your home. All you need to do is test for radon. Testing is easy and should only take a few minutes of your time.

The amount of radon in the air is measured in "picocuries per liter of air," or "pCi/L." There are many kinds of low-cost "do it yourself" radon test kits you can get through the mail and in some hardware stores and other retail outlets. If you prefer, or if you are buying or selling a home, you can hire a qualified tester to do the testing for you. You should first contact your state radon office about obtaining a list of qualified testers. You can also contact a private radon proficiency program for lists of privately certified radon professionals serving your area. For links and more information, visit <https://www.epa.gov/radon/find-radon-test-kit-or-measurement-and-mitigation-professional>.

There are Two General Ways to Test for Radon:

SHORT-TERM TESTING:

The quickest way to test is with short-term tests. Short-term tests remain in your home for two days to 90 days, depending on the device. "Charcoal canisters," "alpha track," "electret ion chamber," "continuous monitors," and "charcoal liquid scintillation" detectors are most commonly used for short-term testing. Because radon levels tend to vary from day to day and season to season, a short-term test is less likely than a long-term test to tell you your year-round average radon level. If you need results quickly, however, a short-term test followed by a second short-term test may be used to decide whether to fix your home (see also page 7 under Home Sales).

**Testing is easy
and should only
take a few
minutes of
your time.**

LONG-TERM TESTING:

Long-term tests remain in your home for more than 90 days. "Alpha track" and "electret" detectors are commonly used for this type of testing. A long-term test will give you a reading that is more likely to tell you your home's year-round average radon level than a short-term test.

How To Use a Test Kit:

Follow the instructions that come with your test kit. If you are doing a short-term test, close your windows and outside doors and keep them closed as much as possible during the test. Heating and air conditioning system fans that re-circulate air may be operated. Do not operate fans or other machines which bring in air from outside. Fans that are part of a radon-reduction system or small exhaust fans operating only for short periods of time may run during the test. If you are doing a short-term test lasting just 2 or 3 days, be sure to close your windows and outside doors at least 12 hours **before** beginning the test, too. You should not conduct

HOW TO TEST YOUR HOME *continued*

short-term tests lasting just 2 or 3 days during unusually severe storms or periods of unusually high winds. The test kit should be placed in the lowest lived-in level of the home (for example, the basement if it is frequently used, otherwise the first floor). It should be put in a room that is used regularly (like a living room, playroom, den, or bedroom) but **not** your kitchen or bathroom. Place the kit at least 20 inches above the floor in a location where it won't be disturbed—away from drafts, high heat, high humidity, and exterior walls. Leave the kit in place for as long as the package says. Once you've finished the test, reseal the package and send it to the lab specified on the package right away for analysis. You should receive your test results within a few weeks.

EPA Recommends the Following Testing Steps:

Step 1. *Take a short-term test. If your result is 4 pCi/L or higher, take a follow-up test (Step 2) to be sure.*

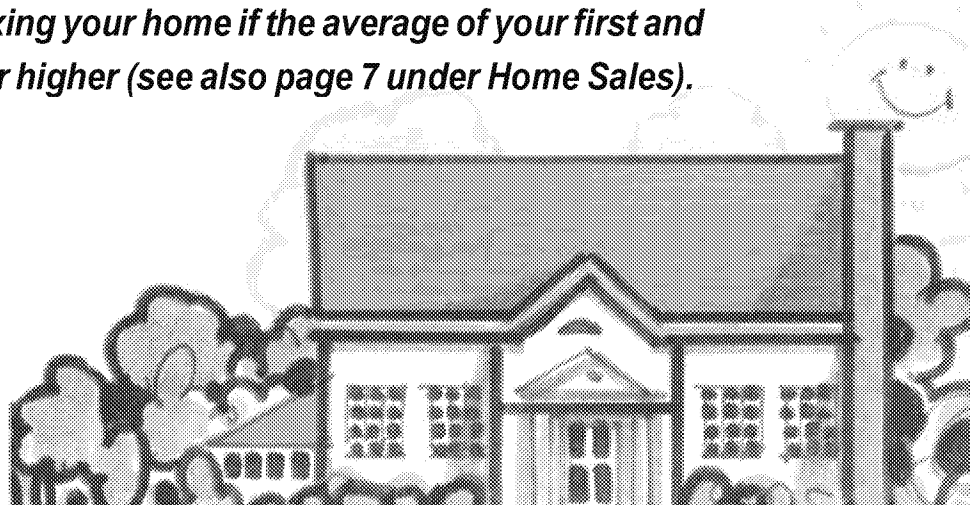
Step 2. *Follow up with either a long-term test or a second short-term test:*

- *For a better understanding of your year-round average radon level, take a long-term test.*
- *If you need results quickly, take a second short-term test.*

The higher your initial short-term test result, the more certain you can be that you should take a short-term rather than a long-term follow up test. If your first short-term test result is more than twice EPA's 4 pCi/L action level, you should take a second short-term test immediately.

Step 3. • *If you followed up with a long-term test: Fix your home if your long-term test result is 4 pCi/L or more.*

- *If you followed up with a second short-term test: The higher your short-term results, the more certain you can be that you should fix your home. Consider fixing your home if the average of your first and second test is 4 pCi/L or higher (see also page 7 under Home Sales).*



WHAT YOUR TEST RESULTS MEAN

The average indoor radon level is estimated to be about 1.3 pCi/L, and about 0.4 pCi/L of radon is normally found in the outside air. The U.S. Congress has set a long-term goal that indoor radon levels be no more than outdoor levels. While this goal is not yet technologically achievable in all cases, most homes today *can* be reduced to 2 pCi/L or below.

Sometimes short-term tests are less definitive about whether or not your home is above 4 pCi/L. This can happen when your results are close to 4 pCi/L. For example, if the average of your two short-term test results is 4.1 pCi/L, there is about a 50% chance that your year-round average is somewhat below 4 pCi/L. However, EPA believes that any radon exposure carries some risk—no level of radon is safe. Even radon levels below 4 pCi/L pose some risk, and you can reduce your risk of lung cancer by lowering your radon level.

If your living patterns change and you begin occupying a lower level of your home (such as a basement) you should retest your home on that level.

Even if your test result is below 4 pCi/L, you may want to test again sometime in the future.

Test your home now and save your results. If you find high radon levels, fix your home before you decide to sell it.

RADON AND HOME SALES

More and more, home buyers and renters are asking about radon levels before they buy or rent a home. Because real estate sales happen quickly, there is often little time to deal with radon and other issues. The best thing to do is to test for radon NOW and save the results in case the buyer is interested in them. Fix a problem if it exists so it won't complicate your home sale. If you are planning to move, review EPA's pamphlet "Home Buyer's and Seller's Guide to Radon," which addresses some common questions (<https://www.epa.gov/radon/home-buyers-and-sellers-guide-radon>). You can also use the results of two short-term tests done side-by-side (four inches apart) to decide whether to fix your home.

During home sales:

- *Buyers often ask if a home has been tested, and if elevated levels were reduced.*
- *Buyers frequently want tests made by someone who is not involved in the home sale. Your state radon office (<https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>) can assist you in identifying a qualified tester.*
- *Buyers might want to know the radon levels in areas of the home (like a basement they plan to finish that the seller might not otherwise test).*

Today many homes are built to help prevent radon from coming in. Building codes in your state or local area may require these radon-resistant construction features. If you are buying or renting a new home, ask the owner or builder if it has radon-resistant features. The EPA recommends building new homes with radon-resistant features in high radon potential (Zone 1) areas. Even if built radon-resistant, every new home should be tested for radon after occupancy. If you have a test result of 4 pCi/L or more, consult a qualified mitigator (<http://www.epa.gov/radon/find-radon-test-kit-or-measurement-and-mitigation-professional#who>) to estimate the cost of upgrading to an active system by adding a vent fan to reduce the radon level. In an existing home, the cost to install a radon mitigation system is about the same as for other common home repairs.

RADON IN WATER

There are two main sources for the radon in your home's indoor air, the soil and the water supply. Compared to radon entering the home through water, radon entering your home through the soil is usually a much larger risk.

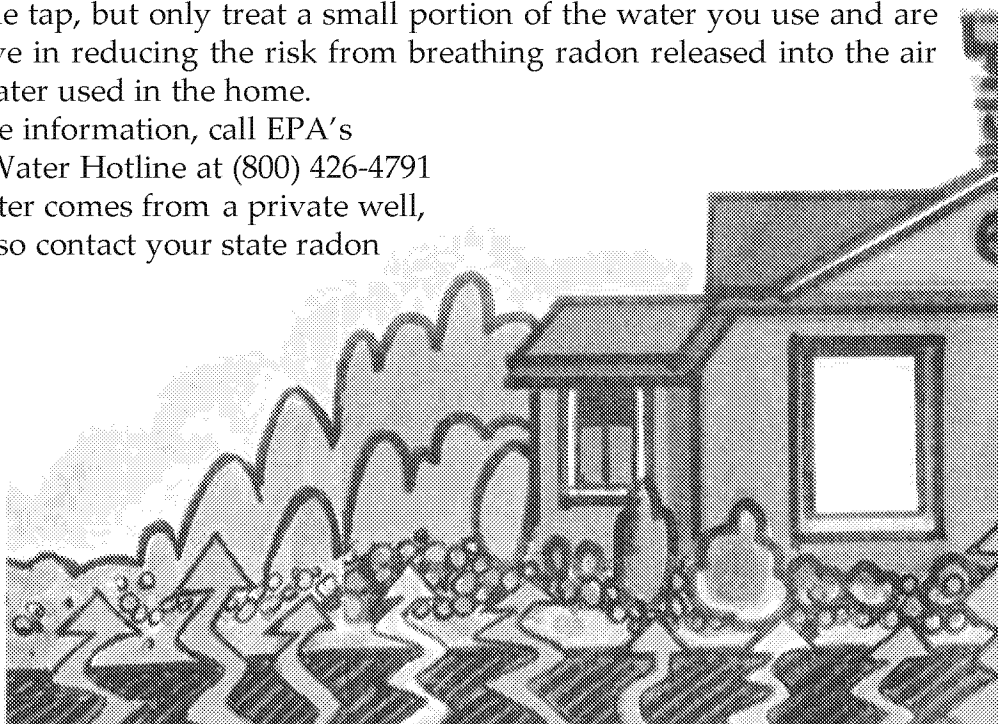
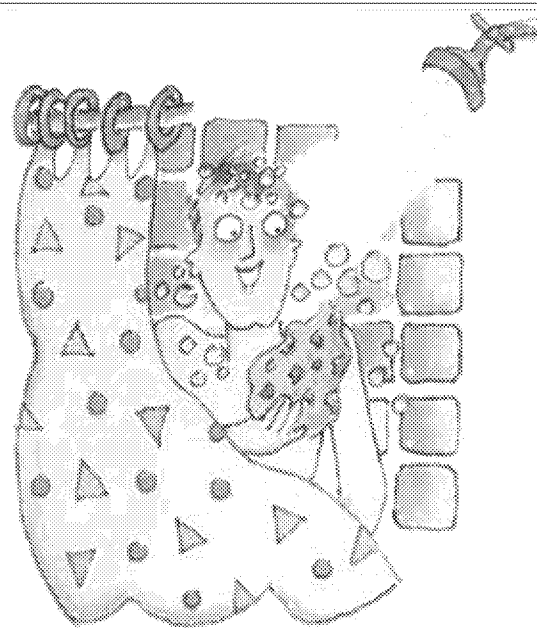
The radon in your water supply poses an inhalation risk and an ingestion risk. Research has shown that your risk of lung cancer from breathing radon in air is much larger than your risk of stomach cancer from swallowing water with radon in it. Most of your risk from radon in water comes from radon released into the air when water is used for showering and other household purposes.

Radon in your home's water is not usually a problem when its source is surface water. A radon in water problem is more likely when its source is ground water, e.g., a private well or a public water supply system that uses ground water. If you are concerned that radon may be entering your home through the water and your water comes from a public water supply, contact your water supplier.

If you've tested your private well and have a radon in water problem, it can be fixed. Your home's water supply can be treated in two ways. Point-of-entry treatment can effectively remove radon from the water before it enters your home. Point-of-use treatment devices remove radon from your water at the tap, but only treat a small portion of the water you use and are not effective in reducing the risk from breathing radon released into the air from all water used in the home.

For more information, call EPA's Drinking Water Hotline at (800) 426-4791. If your water comes from a private well, you can also contact your state radon office.

If you've tested the air in your home and found a radon problem, and your water comes from a well, have your water tested.



HOW TO LOWER THE RADON LEVEL IN YOUR HOME

Since there is no known safe level of radon, there can always be some risk. But the risk can be reduced by lowering the radon level in your home.

There are several proven methods to reduce radon in your home, but the one primarily used is a vent pipe system and fan, which pulls radon from beneath the house and vents it to the outside. This system, known as a soil suction radon reduction system, does not require major changes to your home. Sealing foundation cracks and other openings makes this kind of system more effective and cost-efficient. Similar systems can also be installed in houses with crawl spaces. Radon contractors can use other methods that may also work in your home. The right system depends on the design of your home and other factors.

Ways to reduce radon in your home are discussed in EPA's *Consumer's Guide to Radon Reduction*. You can get a copy at [about-radon https://www.epa.gov/radon/publications-about-radon](https://www.epa.gov/radon/publications-about-radon).

The cost of reducing radon in your home depends on how your home was built and the extent of the radon problem. Most homes can be fixed for about the same cost as other common home repairs. The cost to fix can vary widely; consult with your state radon office or get one or more estimates from qualified mitigators. The cost is much less if a passive system was installed during construction.

RADON AND HOME RENOVATIONS

If you are planning any major structural renovation, such as converting an unfinished basement area into living space, it is especially important to test the area for radon before you begin the renovation. If your test results indicate a radon problem, radon-resistant techniques can be inexpensively included as part of the renovation. Because major renovations can change the level of radon in any home, always test again after work is completed.



HOW TO LOWER THE RADON LEVEL IN YOUR HOME *continued*

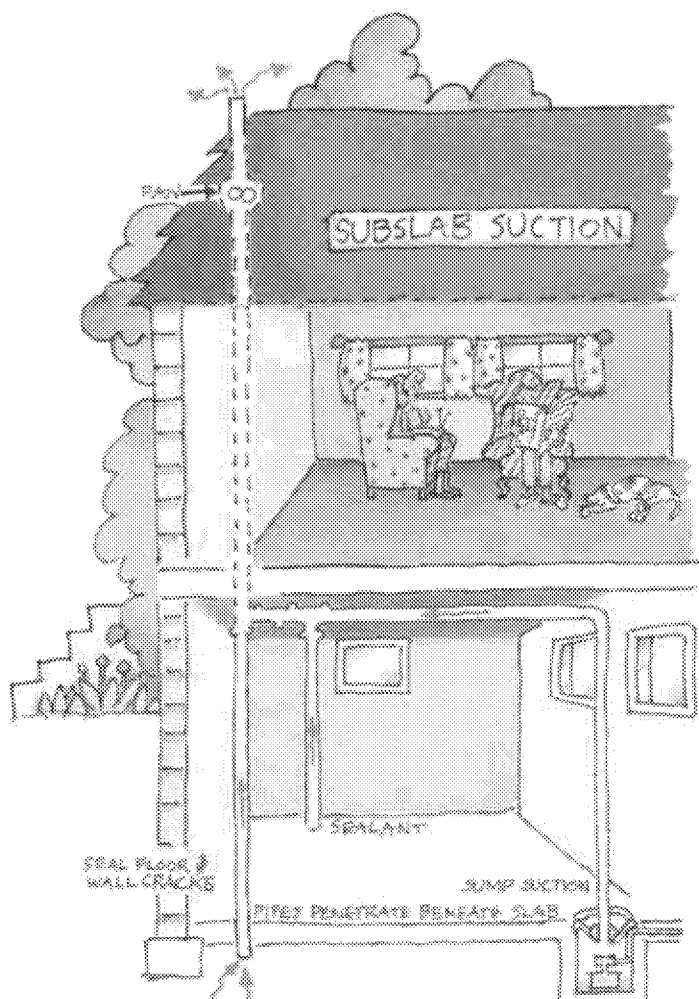
**Most homes can
be fixed for
about the same
cost as other
common home
repairs.**

Lowering high radon levels requires technical knowledge and special skills. You should use a contractor who is trained to fix radon problems. A qualified contractor can study the radon problem in your home and help you pick the right treatment method.

Check with your state radon office for names of qualified or state certified radon contractors in your area. You can also contact private radon proficiency programs for lists of privately certified radon professionals in your area. For more information on private radon proficiency programs, visit <https://www.epa.gov/radon/find-radon-test-kit-or-measurement-and-mitigation-professional>. Picking someone to fix your radon problem is much like choosing a contractor for other home repairs—you may want to get references and more than one estimate.

If you are considering fixing your home's radon problem yourself, you should first contact your state radon office for guidance and assistance <https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>.

You should also test your home again after it is fixed to be sure that radon levels have been reduced. Most soil suction radon reduction systems include a monitor that will indicate whether the system is operating properly. In addition, it's a good idea to retest your home every two years to be sure radon levels remain low.



Note: This diagram is a composite view of several mitigation options. The typical mitigation system usually has only one pipe penetration through the basement floor; the pipe may also be installed on the outside of the house.

THE RISK OF LIVING WITH RADON

Radon gas decays into radioactive particles that can get trapped in your lungs when you breathe. As they break down further, these particles release small bursts of energy. This can damage lung tissue and lead to lung cancer over the course of your lifetime. Not everyone exposed to elevated levels of radon will develop lung cancer. And the amount of time between exposure and the onset of the disease may be many years.

Like other environmental pollutants, there is some uncertainty about the magnitude of radon health risks. However, we know more about radon risks than risks from most other cancer-causing substances. This is because estimates of radon risks are based on studies of cancer in humans (underground miners).

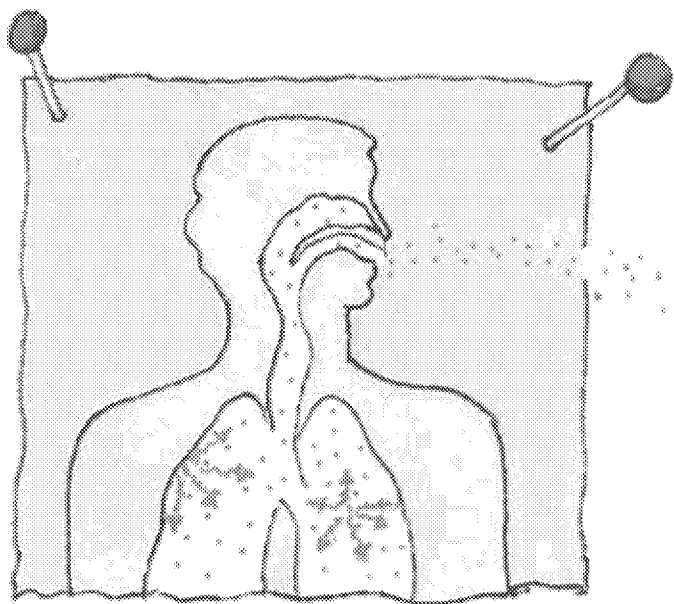
Smoking combined with radon is an especially serious health risk. Stop smoking and lower your radon level to reduce your lung cancer risk.

Children have been reported to have greater risk than adults of certain types of cancer from radiation, but there are currently no conclusive data on whether children are at greater risk than adults from radon.

Your chances of getting lung cancer from radon depend mostly on:

- ***How much radon is in your home***
- ***The amount of time you spend in your home***
- ***Whether you are a smoker or have ever smoked***

Scientists are more certain about radon risks than risks from most other cancer-causing substances.



THE RISK OF LIVING WITH RADON *continued*

RADON RISK IF YOU SMOKE

Radon Level	If 1,000 people who smoked were exposed to this level over a lifetime*...	The risk of cancer from radon exposure compares to**...	WHAT TO DO: Stop Smoking and...
20 pCi/L	About 260 people could get lung cancer	◀ 250 times the risk of drowning	Fix your home
10 pCi/L	About 150 people could get lung cancer	◀ 200 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 120 people could get lung cancer	◀ 30 times the risk of dying in a fall	Fix your home
4 pCi/L	About 62 people could get lung cancer	◀ 5 times the risk of dying in a car crash	Fix your home
2 pCi/L	About 32 people could get lung cancer	◀ 6 times the risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 20 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult)
0.4 pCi/L		(Average outdoor radon level)	

Note: If you are a former smoker, your risk may be lower.

It's never too late to reduce your risk of lung cancer. Don't wait to test and fix a radon problem. If you are a smoker, stop smoking.

RADON RISK IF YOU'VE NEVER SMOKED

Radon Level	If 1,000 people who never smoked were exposed to this level over a lifetime*...	The risk of cancer from radon exposure compares to**...	WHAT TO DO:
20 pCi/L	About 36 people could get lung cancer	◀ 35 times the risk of drowning	Fix your home
10 pCi/L	About 18 people could get lung cancer	◀ 20 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 15 people could get lung cancer	◀ 4 times the risk of dying in a fall	Fix your home
4 pCi/L	About 7 people could get lung cancer	◀ The risk of dying in a car crash	Fix your home
2 pCi/L	About 4 people could get lung cancer	◀ The risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 2 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult)
0.4 pCi/L		(Average outdoor radon level)	

Note: If you are a former smoker, your risk may be higher.

*Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).

**Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.

RADON MYTHS AND FACTS

MYTH: Scientists aren't sure radon really is a problem.

FACT: Although some scientists dispute the precise number of deaths due to radon, all major health organizations (like the Centers for Disease Control, the American Lung Association and the American Medical Association) agree with estimates that radon causes thousands of preventable lung cancer deaths every year. This is especially true among smokers, since the risk to smokers is much greater than to non-smokers.

MYTH: Radon testing is difficult, time consuming and expensive.

FACT: Radon testing is easy. You can test your home yourself or hire a qualified radon test company. Either approach takes only a small amount of time and effort.

MYTH: Homes with radon problems can't be fixed.

FACT: There are simple solutions to radon problems in homes. Hundreds of thousands of homeowners have already fixed radon problems in their homes. Most homes can be fixed for about the same cost as other common home repairs; check with one or more qualified mitigators. Call your state radon office (www.epa.gov/radon/whereyoulive.html) for help in identifying qualified mitigation contractors.

MYTH: Radon only affects certain kinds of homes.

FACT: House construction can affect radon levels. However, radon can be a problem in homes of all types: old homes, new homes, drafty homes, insulated homes, homes with basements, homes without basements. Local geology, construction materials, and how the home was built are among the factors that can affect radon levels in homes.

MYTH: Radon is only a problem in certain parts of the country.

FACT: High radon levels have been found in every state. Radon problems do vary from area to area, but the only way to know your radon level is to test.

MYTH: A neighbor's test result is a good indication of whether your home has a problem.

FACT: It's not. Radon levels can vary greatly from home to home. The only way to know if your home has a radon problem is to test it.

RADON MYTHS AND FACTS *continued*

MYTH: Everyone should test their water for radon.

FACT: Although radon gets into some homes through water, it is important to first test the air in the home for radon. If your water comes from a public water system that uses ground water, call your water supplier. If high radon levels are found and the home has a private well, call the Safe Drinking Water Hotline at (800) 426-4791 for information on testing your water.

MYTH: It's difficult to sell homes where radon problems have been discovered.

FACT: Where radon problems have been fixed, home sales have not been blocked or frustrated. The added protection is sometimes a good selling point.

MYTH: I've lived in my home for so long, it doesn't make sense to take action now.

FACT: You will reduce your risk of lung cancer when you reduce radon levels, even if you've lived with a radon problem for a long time.

MYTH: Short-term tests can't be used for making a decision about whether to fix your home.

FACT: A short-term test followed by a second short-term test* can be used to decide whether to fix your home. However, the closer the average of your two short-term tests is to 4 pCi/L, the less certain you can be about whether your year-round average is above or below that level. Keep in mind that radon levels below 4 pCi/L still pose some risk. Radon levels can be reduced in most homes to 2 pCi/L or below.

**If the radon test is part of a real estate transaction, the result of two short-term tests can be used in deciding whether to mitigate. For more information, see EPA's "Home Buyer's and Seller's Guide to Radon."*

FOR FURTHER INFORMATION

EPA Radon Website

<https://www.epa.gov/radon>

EPA's radon page includes links to publications, hotlines, private proficiency programs and more.

Frequent Questions:

<https://iaq.zendesk.com/hc/en-us/sections/202349927>

Radon Hotlines

1-800-SOS-RADON (767-7236)*

Purchase radon test kits by phone.

1-800-55RADON (557-2366)*

Get live help for your radon questions.

1-800-644-6999*

Radon Fix-It Hotline. For general information on finding and reducing the radon level in your home.

1-866-528-3187*

Línea Directa de Información sobre Radón en Español. Hay operadores disponibles desde las 9:00 AM hasta las 5:00 PM para darle información sobre radón y como ordenar un kit para hacer la prueba de radón en su hogar.

1-800-426-4791

Safe Drinking Water Hotline. For general information on drinking water, radon in water, testing and treatment, and standards for radon in drinking water. Operated under a contract with EPA.

*Operated by Kansas State University in partnership with EPA.

EPA Regional Offices

<https://www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information>. Check the above website for a listing of your EPA regional office.

Ordering Radon Publications

Many EPA radon publications are available from <https://www.epa.gov/radon/publications-about-radon>

Radon publications may be ordered through the National Service Center for Environmental Publications (NSCEP) by calling 1-800-490-9198, by visiting the NSCEP website at <https://www.epa.gov/nscep> or by email at nscep@lmsolas.com.



Surgeon General Health Advisory

“Indoor radon is the second-leading cause of lung cancer in the United States and breathing it over prolonged periods can present a significant health risk to families all over the country. It’s important to know that this threat is completely preventable. Radon can be detected with a simple test and fixed through well-established venting techniques.”

January 2005

U.S. EPA Assessment of Risks from Radon in Homes

In June 2003, the EPA revised its risk estimates for radon exposure in homes. EPA estimates that about 21,000 annual lung cancer deaths are radon related. EPA also concluded that the effects of radon and cigarette smoking are synergistic, so that smokers are at higher risk from radon. EPA’s revised estimates are based on the National Academy of Sciences 1998 BEIR VI (Biological Effects of Ionizing Radiation) Report which concluded that radon is the second leading cause of lung cancer after smoking.



Indoor Environments Division (6609J)
EP 402/K-12/002 | May 2012 | www.epa.gov/radon

ATTACHMENT 2

ATSDR TOXFAQ GUIDES FOR CHEMICALS IDENTIFIED AT SITE AND IN AIR

Tetrachloroethylene - ToxFAQs™

CAS # 127-18-4

This fact sheet answers the most frequently asked health questions (FAQs) about tetrachloroethylene. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Tetrachloroethylene is a manufactured chemical used for dry cleaning and metal degreasing. Exposure to very high concentrations of tetrachloroethylene can cause dizziness, headaches, sleepiness, incoordination, confusion, nausea, unconsciousness, and even death. Tetrachloroethylene has been found in at least 945 of the 1,699 National Priorities List sites identified by U.S. Environmental Protection Agency (EPA).

What is tetrachloroethylene?

Tetrachloroethylene is a nonflammable colorless liquid. Other names for tetrachloroethylene include perchloroethylene, PCE, perc, tetrachloroethene, and perchlor. Most people can smell tetrachloroethylene when it is present in the air at a level of 1 part in 1 million parts of air (1 ppm) or more.

Tetrachloroethylene is used as a dry cleaning agent and metal degreasing solvent. It is also used as a starting material (building block) for making other chemicals and is used in some consumer products.

What happens to tetrachloroethylene when it enters the environment?

- Tetrachloroethylene can be released into air, water, and soil at places where it is produced or used.
- Tetrachloroethylene breaks down very slowly in the air and so it can be transported long distances in the air. Half of the amount in the air will degrade in approximately 100 days.
- Tetrachloroethylene evaporates quickly from water into air. It is generally slow to break down in water.
- Tetrachloroethylene may evaporate quickly from shallow soils or may filter through the soil and into the groundwater below. It is generally slow to break down in soil.

How might I be exposed to tetrachloroethylene?

- When you bring clothes from the dry cleaners, they will release small amounts of tetrachloroethylene into the air.

- When you drink water containing tetrachloroethylene, you are exposed to it. You might also be exposed to tetrachloroethylene that is released into the air during showering and bathing.
- People residing near contaminated sites or dry cleaning locations may be exposed to higher levels than the general population.
- People working in the dry cleaning industries or using metal degreasing products may be exposed to elevated levels of tetrachloroethylene.

How can tetrachloroethylene affect my health?

Breathing high levels of tetrachloroethylene for a brief period may cause dizziness or drowsiness, headache, and incoordination; higher levels may cause unconsciousness and even death.

Exposure for longer periods to low levels of tetrachloroethylene may cause changes in mood, memory, attention, reaction time, and vision.

Studies in animals exposed to tetrachloroethylene have shown liver and kidney effects, and changes in brain chemistry, but we do not know what these findings mean for humans.

How likely is tetrachloroethylene to cause cancer?

Studies in humans suggest that exposure to tetrachloroethylene might lead to a higher risk of getting bladder cancer, multiple myeloma, or non-Hodgkin's lymphoma, but the evidence is not very strong.

Tetrachloroethylene

CAS # 127-18-4

In animals, tetrachloroethylene has been shown to cause cancers of the liver, kidney, and blood system.

EPA considers tetrachloroethylene likely to be carcinogenic to humans by all routes of exposure. The International Agency for Research on Cancer (IARC) considers tetrachloroethylene probably carcinogenic to humans. The Department of Health and Human Services (DHHS) considers tetrachloroethylene to be reasonable anticipated to be a human carcinogen.

How can tetrachloroethylene affect children?

It is not known whether children are more susceptible than adults to the effects of tetrachloroethylene.

A few studies in humans have suggested that exposure to tetrachloroethylene increased the numbers of babies with birth defects, but these studies were not large enough to clearly answer the question. Studies in animals exposed by inhalation or stomach tube have not shown clear evidence of specific birth defects.

How can families reduce the risks of exposure to tetrachloroethylene?

- Tetrachloroethylene has been found in low levels in some food. You can minimize the risk of your family's exposure by peeling and thoroughly washing fruits and vegetables before cooking.
- Use bottled water if you have concerns about the presence of tetrachloroethylene in your tap water. You may also contact local drinking water authorities and follow their advice.
- Prevent children from playing in dirt or eating dirt if you live near a waste site that has tetrachloroethylene.
- Tetrachloroethylene is widely used as a scouring solvent that removes oils from fabrics, as a carrier solvent, as a fabric finish or water repellent, and as

a metal degreaser/cleaner. Follow instructions on product labels to minimize exposure to tetrachloroethylene.

Is there a medical test to show whether I've been exposed to tetrachloroethylene?

Tetrachloroethylene and its breakdown products (metabolites) can be measured in blood and urine. However, the detection of tetrachloroethylene or its metabolites cannot predict the kind of health effects that might develop from that exposure. Because tetrachloroethylene and its metabolites leave the body fairly rapidly, the tests need to be conducted within days after exposure.

Has the federal government made recommendations to protect human health?

The Occupational Safety and Health Administration (OSHA) has set an 8-hour time weighted average permissible exposure limit of 100 ppm, an acceptable ceiling exposure limit of 200 ppm, and a maximum peak of 300 ppm (not to be exceeded for more than 5 minutes of any 3-hour period).

The National Institute for Occupational Safety and Health (NIOSH) recommends that workplace exposure to tetrachloroethylene be minimized due to concerns about its carcinogenicity.

References

This ToxFAQs™ information is taken from the 2014 Toxicological Profile for Tetrachloroethylene (Draft for Public Comment) produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services in Atlanta, GA

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636, FAX: 770-488-4178.

ToxFAQs™ Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaqs/index.asp>.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.



1,2-DICHLOROETHENE

CAS # 540-59-0, 156-59-2, and 156-60-5

Agency for Toxic Substances and Disease Registry ToxFAQs

September 1997

This fact sheet answers the most frequently asked health questions (FAQs) about 1,2-dichloroethene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to 1,2-dichloroethene occurs mainly in workplaces where it is made or used. Breathing high levels of 1,2-dichloroethene can make you feel nauseous, drowsy, and tired. *cis*-1,2-Dichloroethene has been found in at least 146 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA). *trans*-1,2-Dichloroethene was found in at least 563 NPL sites. 1,2-Dichloroethene was found at 336 sites, but the isomer (*cis*- or *trans*-) was not specified.

What is 1,2-dichloroethene?

(Pronounced 1,2-dī-klôr' ô-ěth'ēn)

1,2-Dichloroethene, also called 1,2-dichloroethylene, is a highly flammable, colorless liquid with a sharp, harsh odor. It is used to produce solvents and in chemical mixtures. You can smell very small amounts of 1,2-dichloroethene in air (about 17 parts of 1,2-dichloroethene per million parts of air [17 ppm]).

There are two forms of 1,2-dichloroethene; one is called *cis*-1,2-dichloroethene and the other is called *trans*-1,2-dichloroethene. Sometimes both forms are present as a mixture.

What happens to 1,2-dichloroethene when it enters the environment?

- ☐ 1,2-Dichloroethene evaporates rapidly into air.
- ☐ In the air, it takes about 5-12 days for half of it to break down.
- ☐ Most 1,2-dichloroethene in the soil surface or bodies of water will evaporate into air.
- ☐ 1,2-Dichloroethene can travel through soil or dissolve in water in the soil. It is possible that it can contaminate groundwater.
- ☐ In groundwater, it takes about 13-48 weeks to break down.

- ☐ There is a slight chance that 1,2-dichloroethene will break down into vinyl chloride, a different chemical which is believed to be more toxic than 1,2-dichloroethene.

How might I be exposed to 1,2-dichloroethene?

- ☐ Breathing 1,2-dichloroethene that has leaked from hazardous waste sites and landfills.
- ☐ Drinking contaminated tap water or breathing vapors from contaminated water while cooking, bathing, or washing dishes.
- ☐ Breathing 1,2-dichloroethene, touching it, or touching contaminated materials in the workplace.

How can 1,2-dichloroethene affect my health?

Breathing high levels of 1,2-dichloroethene can make you feel nauseous, drowsy, and tired; breathing very high levels can kill you.

When animals breathed high levels of *trans*-1,2-dichloroethene for short or longer periods of time, their livers and lungs were damaged and the effects were more severe with longer exposure times. Animals that breathed very high

1,2-DICHLOROETHENE

CAS # 540-59-0, 156-59-2, and 156-60-5

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levels of *trans*-1,2-dichloroethene had damaged hearts.

Animals that ingested extremely high doses of *cis*- or *trans*-1,2-dichloroethene died.

Lower doses of *cis*-1,2-dichloroethene caused effects on the blood, such as decreased numbers of red blood cells, and also effects on the liver.

The long-term (365 days or longer) human health effects after exposure to low concentrations of 1,2-dichloroethene aren't known. One animal study suggested that an exposed fetus may not grow as quickly as one that hasn't been exposed.

Exposure to 1,2-dichloroethene hasn't been shown to affect fertility in people or animals.

How likely is 1,2-dichloroethene to cause cancer?

The EPA has determined that *cis*-1,2-dichloroethene is not classifiable as to its human carcinogenicity.

No EPA cancer classification is available for *trans*-1,2-dichloroethene.

Is there a medical test to show whether I've been exposed to 1,2-dichloroethene?

Tests are available to measure concentrations of the breakdown products of 1,2-dichloroethene in blood, urine, and tissues. However, these tests aren't used routinely to determine whether a person has been exposed to this compound. This is because after you are exposed to 1,2-dichloroethene, the breakdown products in your body that are detected with these tests may be the same as those that come from exposure to other chemicals. These tests aren't available in most doctors' offices, but can be done at special laboratories that have the right equipment.

Has the federal government made recommendations to protect human health?

The EPA has set the maximum allowable level of *cis*-1,2-dichloroethene in drinking water at 0.07 milligrams per liter of water (0.07 mg/L) and *trans*-1,2-dichloroethene at 0.1 mg/L.

The EPA requires that any spills or accidental release of 1,000 pounds or more of 1,2-dichloroethene must be reported to the EPA.

The Occupational Health Safety and Health Administration (OSHA) has set the maximum allowable amount of 1,2-dichloroethene in workroom air during an 8-hour workday in a 40-hour workweek at 200 parts of 1,2-dichloroethene per million parts of air (200 ppm).

Glossary

Carcinogenicity: Ability of a substance to cause cancer.

CAS: Chemical Abstracts Service.

Fertility: Ability to reproduce.

Ingest: To eat or drink something.

Milligram (mg): One thousandth of a gram.

ppm: Parts per million.

Solvent: A chemical that can dissolve other substances.

References

This ToxFAQs information is taken from the 1996 Toxicological Profile for 1,2-Dichloroethene produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaq.html>. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.





1,1,1-TRICHLOROETHANE

CAS # 71-55-6

Division of Toxicology and Environmental Medicine ToxFAQs™

July 2006

This fact sheet answers the most frequently asked health questions (FAQs) about 1,1,1-trichloroethane. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to 1,1,1-trichloroethane usually occurs by breathing contaminated air. It is found in building materials, cleaning products, paints, and metal degreasing agents. You are not likely to be exposed to large enough amounts to cause adverse health effects. Inhaling high levels of 1,1,1-trichloroethane can cause you to become dizzy and lightheaded. Exposure to much higher levels can cause unconsciousness and other effects. This substance has been found in at least 823 of the 1,662 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is 1,1,1-trichloroethane?

1,1,1-Trichloroethane is a synthetic chemical that does not occur naturally in the environment. It also is known as methylchloroform, methyltrichloromethane, trichloromethylmethane, and α -trichloromethane. Its registered trade names are chloroethene NU® and Aerothene TT®.

No 1,1,1-trichloroethane is supposed to be manufactured for domestic use in the United States after January 1, 2002 because it affects the ozone layer. 1,1,1-Trichloroethane had many industrial and household uses, including use as a solvent to dissolve other substances, such as glues and paints; to remove oil or grease from manufactured metal parts; and as an ingredient of household products such as spot cleaners, glues, and aerosol sprays.

What happens to 1,1,1-trichloroethane when it enters the environment?

- ☐ Most of the 1,1,1-trichloroethane released into the environment enters the air, where it lasts for about 6 years.
- ☐ Once in the air, it can travel to the ozone layer where sunlight can break it down into chemicals that may reduce the ozone layer.
- ☐ Contaminated water from landfills and hazardous waste sites can contaminate surrounding soil and nearby surface water or groundwater.
- ☐ From lakes and rivers, most of the 1,1,1-trichloroethane evaporates quickly into the air.

☐ Water can carry 1,1,1-trichloroethane through the soil and into the groundwater where it can evaporate and pass through the soil as a gas, then be released to the air.

☐ Organisms living in soil or water may also break down 1,1,1-trichloroethane.

☐ It will not build up in plants or animals.

How might I be exposed to 1,1,1-trichloroethane?

☐ Breathing 1,1,1-trichloroethane in contaminated outdoor and indoor air. Because 1,1,1-trichloroethane was used so frequently in home and office products, you are likely to be exposed to higher levels indoors than outdoors or near hazardous waste sites. However, since 2002, 1,1,1-trichloroethane is not expected to be commonly used, and therefore, the likelihood of being exposed to it is remote.

☐ In the workplace, you could have been exposed to 1,1,1-trichloroethane while using some metal degreasing agents, paints, glues, and cleaning products.

☐ Ingesting contaminated drinking water and food.

How can 1,1,1-trichloroethane affect my health?

If you breathe air containing high levels of 1,1,1-trichloroethane for a short time, you may become dizzy and lightheaded and possibly lose your coordination. These effects rapidly disappear after you stop breathing contaminated air. If you breathe in much higher levels, you may become unconscious, your blood pressure may decrease, and your heart may stop beating. Whether breathing low levels of 1,1,1-trichloroethane for a long

1,1,1-TRICHLOROETHANE

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time causes harmful effects is not known. Studies in animals show that breathing air that contains very high levels of 1,1,1-trichloroethane damages the breathing passages and causes mild effects in the liver, in addition to affecting the nervous system. There are no studies in humans that determine whether eating food or drinking water contaminated with 1,1,1-trichloroethane could harm health. Placing large amounts of 1,1,1-trichloroethane in the stomachs of animals has caused effects on the nervous system, mild liver damage, unconsciousness, and even death. If your skin contacts 1,1,1-trichloroethane, you might feel some irritation. Studies in animals suggest that repeated exposure of the skin might affect the liver and that very large amounts may cause death. These effects occurred only when evaporation was prevented.

How likely is 1,1,1-trichloroethane to cause cancer?

Available information does not indicate that 1,1,1-trichloroethane causes cancer. The International Agency for Research on Cancer (IARC) and the EPA have determined that 1,1,1-trichloroethane is not classifiable as to its carcinogenicity in humans.

How can 1,1,1-trichloroethane affect children?

Children exposed to large amounts of 1,1,1-trichloroethane probably would be affected in the same manner as adults. In animals, it has been shown that 1,1,1-trichloroethane can pass from the mother's blood into a fetus. When pregnant mice were exposed to high levels of 1,1,1-trichloroethane in air, their babies developed more slowly than normal and had some behavioral problems. However, whether similar effects occur in humans has not been demonstrated.

How can families reduce the risk of exposure to 1,1,1-trichloroethane?

Children can be exposed to 1,1,1-trichloroethane in household products, such as adhesives and cleaners. Parents should store household chemicals out of reach of young children to prevent accidental poisonings or skin irritation. Always store household chemicals in their original labeled containers. Never store household chemicals in containers that children would find attractive to eat or drink from, such as old soda bottles. Keep your Poison Control Center's number near the phone.

Sometimes older children sniff household chemicals in an attempt to get high. Your children may be exposed to 1,1,1-trichloroethane by inhaling products containing it. Talk with your children about the dangers of sniffing chemicals.

Is there a medical test to show whether I've been exposed to 1,1,1-trichloroethane?

Samples of your breath, blood, and urine can be tested to determine if you have recently been exposed to 1,1,1-trichloroethane. In some cases, these tests can estimate how much 1,1,1-trichloroethane has entered your body. To be of any value, samples of your breath or blood have to be taken within hours after exposure, and samples of urine have to be taken within 2 days after exposure. However, these tests will not tell you whether your health will be affected by exposure to 1,1,1-trichloroethane. The exposure tests are not routinely available in hospitals and clinics because they require special analytical equipment.

Has the federal government made recommendations to protect human health?

EPA regulates the levels of 1,1,1-trichloroethane that are allowable in drinking water. The highest level of 1,1,1-trichloroethane allowed in drinking water is 0.2 parts 1,1,1-trichloroethane per 1 million parts of water (0.2 ppm).

The Occupational Safety and Health Administration (OSHA) has set a limit of 350 parts 1,1,1-trichloroethane per 1 million parts of air (350 ppm) in the workplace.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2006. Toxicological Profile for 1,1,1-Trichloroethane (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaq.html>. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.



Vinyl Chloride - ToxFAQs™

CAS # 75-01-4

This fact sheet answers the most frequently asked health questions (FAQs) about vinyl chloride. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to vinyl chloride occurs mainly in the workplace. Breathing high levels of vinyl chloride for short periods of time can cause dizziness, sleepiness, unconsciousness, and at extremely high levels can cause death. Breathing vinyl chloride for long periods of time can result in permanent liver damage, immune reactions, nerve damage, and liver cancer. This substance has been found in at least 616 of the 1,662 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is vinyl chloride?

Vinyl chloride is a colorless gas. It burns easily and it is not stable at high temperatures. It has a mild, sweet odor. It is a manufactured substance that does not occur naturally. It can be formed when other substances such as trichloroethane, trichloroethylene, and tetrachloroethylene are broken down. Vinyl chloride is used to make polyvinyl chloride (PVC). PVC is used to make a variety of plastic products, including pipes, wire and cable coatings, and packaging materials.

Vinyl chloride is also known as chloroethene, chloroethylene, and ethylene monochloride.

What happens to vinyl chloride when it enters the environment?

- Liquid vinyl chloride evaporates easily. Vinyl chloride in water or soil evaporates rapidly if it is near the surface.
- Vinyl chloride in the air breaks down in a few days to other substances, some of which can be harmful.
- Small amounts of vinyl chloride can dissolve in water.
- Vinyl chloride is unlikely to build up in plants or animals that you might eat.

How might I be exposed to vinyl chloride?

- Breathing vinyl chloride that has been released from plastics industries, hazardous waste sites, and landfills.

- Breathing vinyl chloride in air or during contact with your skin or eyes in the workplace.
- Drinking water from contaminated wells.

How can vinyl chloride affect my health?

Breathing high levels of vinyl chloride can cause you to feel dizzy or sleepy. Breathing very high levels can cause you to pass out, and breathing extremely high levels can cause death.

Some people who have breathed vinyl chloride for several years have changes in the structure of their livers. People are more likely to develop these changes if they breathe high levels of vinyl chloride. Some people who work with vinyl chloride have nerve damage and develop immune reactions. The lowest levels that produce liver changes, nerve damage, and immune reaction in people are not known. Some workers exposed to very high levels of vinyl chloride have problems with the blood flow in their hands. Their fingers turn white and hurt when they go into the cold.

The effects of drinking high levels of vinyl chloride are unknown. If you spill vinyl chloride on your skin, it will cause numbness, redness, and blisters.

Animal studies have shown that long-term exposure to vinyl chloride can damage the sperm and testes.

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How likely is vinyl chloride to cause cancer?

The U.S. Department of Health and Human Services (DHHS) has determined that vinyl chloride is a known carcinogen. Studies in workers who have breathed vinyl chloride over many years showed an increased risk of liver, brain, lung cancer, and some cancers of the blood have also been observed in workers.

How can vinyl chloride affect children?

It has not been proven that vinyl chloride causes birth defects in humans, but studies in animals suggest that vinyl chloride might affect growth and development. Animal studies also suggest that infants and young children might be more susceptible than adults to vinyl chloride-induced cancer.

How can families reduce the risk of exposure to vinyl chloride?

Tobacco smoke contains low levels of vinyl chloride, so limiting your family's exposure to cigarette or cigar smoke may help reduce their exposure to vinyl chloride.

Is there a medical test to determine whether I've been exposed to vinyl chloride?

The results of several tests can sometimes show if you have been exposed to vinyl chloride. Vinyl chloride can be measured in your breath, but the test must be done shortly after exposure. This is not helpful for measuring very low levels of vinyl chloride.

The amount of the major breakdown product of vinyl chloride, thiodiglycolic acid, in the urine may give some information about exposure. However, this test must be done shortly after exposure and does not reliably indicate the level of exposure.

Has the federal government made recommendations to protect human health?

Vinyl chloride is regulated in drinking water, food, and air. The EPA requires that the amount of vinyl chloride in drinking water not exceed 0.002 milligrams per liter (mg/L) of water.

The Occupational Safety and Health Administration (OSHA) has set a limit of 1 part vinyl chloride per 1 million parts of air (1 ppm) in the workplace.

The Food and Drug Administration (FDA) regulates the vinyl chloride content of various plastics. These include plastics that carry liquids and plastics that contact food. The limits for vinyl chloride content vary depending on the nature of the plastic and its use.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2006. Toxicological Profile for Vinyl Chloride (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaqs/index.asp>.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Trichloroethylene - ToxFAQs™

CAS # 79-01-6

This fact sheet answers the most frequently asked health questions (FAQs) about trichloroethylene. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Trichloroethylene is used as a solvent for cleaning metal parts. Exposure to very high concentrations of trichloroethylene can cause dizziness, headaches, sleepiness, incoordination, confusion, nausea, unconsciousness, and even death. The Environmental Protection Agency (EPA) and the International Agency for Research on Cancer (IARC) classify trichloroethylene as a human carcinogen. Trichloroethylene has been found in at least 1,045 of the 1,699 National Priorities List sites identified by the EPA.

What is trichloroethylene?

Trichloroethylene is a colorless, volatile liquid. Liquid trichloroethylene evaporates quickly into the air. It is nonflammable and has a sweet odor.

The two major uses of trichloroethylene are as a solvent to remove grease from metal parts and as a chemical that is used to make other chemicals, especially the refrigerant, HFC-134a. Trichloroethylene was once used as an anesthetic for surgery.

What happens to trichloroethylene when it enters the environment?

- Trichloroethylene can be released to air, water, and soil at places where it is produced or used.
- Trichloroethylene is broken down quickly in air.
- Trichloroethylene breaks down very slowly in soil and water and is removed mostly through evaporation to air.
- It is expected to remain in groundwater for long time since it is not able to evaporate.
- Trichloroethylene does not build up significantly in plants or animals.

How might I be exposed to trichloroethylene?

- Breathing trichloroethylene in contaminated air.
- Drinking contaminated water.
- Workers at facilities using this substance for metal degreasing are exposed to higher levels of trichloroethylene.
- If you live near such a facility or near a hazardous waste site containing trichloroethylene, you may also have higher exposure to this substance.

How can trichloroethylene affect my health?

Exposure to moderate amounts of trichloroethylene may cause headaches, dizziness, and sleepiness; large amounts may cause coma and even death. Eating or breathing high levels of trichloroethylene may damage some of the nerves in the face. Exposure to high levels can also result in changes in the rhythm of the heartbeat, liver damage, and evidence of kidney damage. Skin contact with concentrated solutions of trichloroethylene can cause skin rashes.

There is some evidence exposure to trichloroethylene in the work place may cause scleroderma (a systemic autoimmune disease) in some people. Some men occupationally-exposed to trichloroethylene and other chemicals showed decreases in sex drive, sperm quality, and reproductive hormone levels.

How likely is trichloroethylene to cause cancer?

There is strong evidence that trichloroethylene can cause kidney cancer in people and some evidence for trichloroethylene-induced liver cancer and malignant lymphoma. Lifetime exposure to trichloroethylene resulted in increased liver cancer in mice and increased kidney cancer and testicular cancer in rats.

The National Toxicology Program (NTP) has determined that trichloroethylene is a "known human carcinogen". The EPA and the International Agency for Research on Cancer (IARC) have determined that trichloroethylene is "carcinogenic to humans."

Trichloroethylene

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How can trichloroethylene affect children?

It is not known whether children are more susceptible than adults to the effects of trichloroethylene.

Some human studies indicate that trichloroethylene may cause developmental effects such as spontaneous abortion, congenital heart defects, central nervous system defects, and small birth weight. However, these people were exposed to other chemicals as well.

In some animal studies, exposure to trichloroethylene during development caused decreases in body weight, increases in heart defects, changes to the developing nervous system, and effects on the immune system.

How can families reduce the risk of exposure to trichloroethylene?

- Avoid drinking water from sources that are known to be contaminated with trichloroethylene. Use bottled water if you have concerns about the presence of chemicals in your tap water. You may also contact local drinking water authorities and follow their advice.
- Discourage your children from putting objects in their mouths. Make sure that they wash their hands frequently and before eating.
- Prevent children from playing in dirt or eating dirt if you live near a waste site that has trichloroethylene.
- Trichloroethylene is used in many industrial products. Follow instructions on product labels to minimize exposure to trichloroethylene.

Is there a medical test to show whether I've been exposed to trichloroethylene?

Trichloroethylene and its breakdown products (metabolites) can be measured in blood and urine. However, the detection of trichloroethylene or its metabolites cannot predict the kind of health effects that might develop from that exposure. Because trichloroethylene and its metabolites leave the body fairly rapidly, the tests need to be conducted within days after exposure.

Has the federal government made recommendations to protect human health?

The EPA set a maximum contaminant goal (MCL) of 0.005 milligrams per liter (mg/L; 5 ppb) as a national primary drinking standard for trichloroethylene.

The Occupational Safety and Health Administration (OSHA) set a permissible exposure limit (PEL) of 100 ppm for trichloroethylene in air averaged over an 8-hour work day, an acceptable ceiling concentration of 200 ppm provided the 8 hour PEL is not exceeded, and an acceptable maximum peak of 300 ppm for a maximum duration of 5 minutes in any 2 hours.

The National Institute for Occupational Safety and Health (NIOSH) considers trichloroethylene to be a potential occupational carcinogen and established a recommended exposure limit (REL) of 2 ppm (as a 60-minute ceiling) during its use as an anesthetic agent and 25 ppm (as a 10-hour TWA) during all other exposures.

References

This ToxFAQs™ information is taken from the 2014 Toxicological Profile for Trichloroethylene (Draft for Public Comment) produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ on the web: www.atsdr.cdc.gov/toxFAQs.

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